EU Procurement of In-Vessel Components for ITER

State of progress and next steps

Patrick Lorenzetto

Content

- Blanket First Wall Procurement Package
- Blanket Cooling Manifold Procurement Package
- Divertor Cassette Body & Installation of Plasma Facing Components Procurement Package
- Divertor Inner Vertical Target Procurement Package
Blanket First Wall
Procurement Package

440 shield blanket modules
FW surface: 680 m²

ITER FW covered by 2 designs:
Normal Heat Flux (NHF) (< 2 MW/m²) and
Enhanced Heat Flux (EHF) (up to 4.7 MW/m²).
## Blanket First Wall

**Procurement sharing**

<table>
<thead>
<tr>
<th>Component</th>
<th>Credit (kIUA)</th>
<th>Sharing</th>
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<tbody>
<tr>
<td>P1A Blanket First Wall</td>
<td>87.0</td>
<td>EU=48.4% RF=39.0% CN=12.6%</td>
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<td>P1B Blanket Shield</td>
<td>58.0</td>
<td>CN=50.2% KO=49.8%</td>
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The blanket procurement is “build to print” but DAs are contributing to the design through ITAs. **PA expected to be signed in December 2014.**

Total No. of NHF panels in European supply: 218 (+ ~12 spares) = **230**

- About 9 main variants, according to poloidal location
  - BM 1-2, 6, 10, 11, 12, 13, 14, 15, 18
- An additional 30 minor variants.

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**Blanket First Wall**  
>15-years EU R&D Programme

**HIPped fabrication route**  
selected by the EUDA for the manufacture of FW panels.

- **316L SS / CuCrZr joining**
  - 1040 C, 140 MPa, 2 hrs
  - Post HIP Solution Annealing HT with fast cooling

- **CuCrZr / Beryllium joining**
  - 580 C, 140 MPa, 2 hrs

**Three full scale FW panel prototypes with HIPped Be tiles completed**  
**One full scale FW panel prototype with brazed Be tiles completed.**
Prior to procurement, each DA shall demonstrate its technical capability to fabricate the components with the required quality:

1. **DA qualification stage**
   - Phase 1: Materials, bonding technologies, manufacturing and High Heat Flux (HHF) testing of small-scale mock-ups.
     
     EUDA was the first DA to be qualified
     
     - Phase 2: manufacturing and HHF testing of semi-prototypes.

     **Ongoing**
     - OPE-284: AREVA;
     - OPE-097-2: ATMOSTAT (ALCEN);
     - OPE-394: IBERDROLA-AMEC-MB.

2. **Industrial qualification stage**
   - Qualify industrial companies with the successful manufacture and testing of full-scale FW prototypes.

   **In preparation**
   - Be tiles
   - Central bolt access hole
   - Electrical straps
   - Radial and Lateral pads (SS 660)
   - Cylindrical extension
   - Outlet pipe
   - Silt tapered junction between beam and fingers

   **1m x 1,5 m, ~0.8 ton, 20 to 30 Fingers**
**Blanket First Wall**

**Design and Procurement roadmap**

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**EU procurement of In-Vessel Components for ITER, Patrick Lorenzetto, IBF 2013**

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**Blanket First Wall**

**Near term major calls for tender**

<table>
<thead>
<tr>
<th>Systems</th>
<th>Planned activities</th>
<th>Call</th>
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<td>CuCrZr development for HIP fabrication route</td>
<td>Q3-2013</td>
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<tr>
<td>Blanket Cooling Manifold</td>
<td>Blanket Cooling Manifold design analyses?</td>
<td>Q3-2013?</td>
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<td>Procurement of BCM pipe bundles</td>
<td>Q2-2014</td>
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<td>Manufacture of BCM supports and Filler Shields</td>
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<tr>
<td>Blanket Cooling Manifold</td>
<td>Manufacture of coaxial hydraulic connectors</td>
<td>Q2-2014</td>
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**EU procurement of In-Vessel Components for ITER, Patrick Lorenzetto, IBF 2013**
Blanket Cooling Manifold Procurement Package

Inboard pipe bundle (std sector: 8 pipes)

Outboard pipe bundle (std sector: 12 pipes)
Key dates:

- CDR (Sept 2011); FDR (Nov 2013); PA (March 2014, TBC)
- Remote Handling Class 3
  Number of field welds to be minimized.
- Pipe sizes:
  48.3 x 2.7mm & 60.3 x 2.7mm (multi-pipe concept)
- Theoretical feasibility study performed for the CDR.
- Call for Tender for partial full scale Prototype in progress.
  Expected contact signature: April 2013.
### Blanket Cooling Manifold

**Near term major calls for tender**

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<tr>
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### Divertor Cassette Body

& Installation of PFCs

**Procurement Package**

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**EU procurement of In-Vessel Components for ITER, Patrick Lorenzetto, IBF 2013**
Divertor Cassette Body & Installation
Design

Cassette Assembly ~ 7.9 tons
Cassette Body ~ 4.7 tons

EU procurement of In-Vessel Components for ITER, Patrick Lorenzetto, IBF 2013 17

Divertor Cassette Body & Installation
Procurement Arrangement - scope of supply

17.P1 “Divertor Cassette Integration”

- Manufacturing of:
  - 1 full-scale prototype (qualification)
  - 54 cassettes
  - 6 spare cassettes
  - Installation of the Plasma Facing Components (PFCs);
  - Installation of the diagnostics equipments.

Procurement Arrangement signed on 08.05.2012.

17.P2-B “Divertor Plasma-Facing Components – Inner Vertical Target

- Manufacturing of:
  - 1 full-scale prototype (CFC-W) for the pre-production qualification
  - 1 full-scale prototype (full-W) for the pre-production qualification
  - 54 Inner Vertical Targets (IVT)
  - 6 spare IVTs

Procurement Arrangement signed on 12.03.2010.
Divertor Cassette Body Design

- **XM-19**
- **CuAl10Ni5Fe4**
- **Steel 660**
- **Steel 316 LN**
- **Alloy 718**
- **316 LN IG (lot 1) or XM19 (lot 2)**
- **316 L (pipes)**

Divertor Cassette Body & Installation Procurement roadmap

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- **Signature PA**
- **Framework contract for CB prototype and series**
- **CB Prototype Manufacturing**
- **Re-opening of competition for CB series**
- **CB stage 1**
- **CB stage 2**
- **CB stage 3**
- **CB Series**
- **Contract for CA proto & series**
- **CA Prototype**
- **CA Stage 1**
- **CA Stage 2**
- **54th CA**
- **CA Stage 3**

EU procurement of In-Vessel Components for ITER, Patrick Lorenzetto, IBF 2013
### Divertor Cassette
Near term major calls for tender

<table>
<thead>
<tr>
<th>Systems</th>
<th>Planned activities</th>
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<tbody>
<tr>
<td>Divertor Cassette</td>
<td>Manufacture of divertor cassette bodies</td>
<td>Q1-2013</td>
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<td>Divertor Cassette</td>
<td>Installation of Plasma Facing Components onto the cassette bodies</td>
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<tr>
<td>Divertor IVT</td>
<td>Procurement for IVT series production</td>
<td>Q4-2014</td>
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</table>

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### Divertor Inner Vertical Target
Procurement Package
Divertor Inner Vertical Target Design

54 Cassette Assemblies, ~ 7.9 tons each

17.P1 “Divertor Cassette Integration”
- Manufacturing of:
  - 1 full-scale prototype (qualification)
  - 54 cassettes
  - 6 spare cassettes
  - Installation of the Plasma Facing Components (PFCs);
  - Installation of the diagnostics equipments.
Procurement Arrangement signed on 08.05.2012.

17.P2-B “Divertor Plasma-Facing Components – Inner Vertical Target”
- Manufacturing of:
  - 1 full-scale prototype (CFC-W) for the pre-production qualification
  - 1 full-scale prototype (full-W) for the pre-production qualification
  - 54 Inner Vertical Targets (IVT)
  - 6 spare IVTs
Procurement Arrangement signed on 12.03.2010.

EU procurement of In-Vessel Components for ITER, Patrick Lorenzetto, IBF 2013
ITER Divertor Final Design Review:  
02 - 04 Dec. 2008

ITER pre-qualification programme for the IVT procurement:  

Result:  
The three Qualification Prototypes supplied by EU passed all the acceptance and HHF qualification tests.

Pre-qualification of 2 EU companies:  
ANSALDO NUCLEARE and PLANSEE

Pre-qualification IVT prototypes  
(SNECMA NB41 CFC mattrl.)

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Divertor Inner Vertical Target  
Full-W pre-qualification programme

Tungsten Qualification Programme to address the most critical issues

(1) Technology Development and Validation:  
With full-W small-scale mock-ups;

(2) Full-scale feasibility demonstration:  
with full-scale prototype manufacturing and testing.
HHF tests for small-scale and full-scale prototype straight part  
• 5000 cycles at 10 MW/m² + 300 cycles at 20 MW/m²
HHF test for prototype curved part  
• 5000 cycles at 5 MW/m²

~ 60 mm

Small-scale mock-ups

Full-scale IVT prototype  
~ 2 m

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Small-scale mock-ups and pre-qualification prototypes by HRP (600 °C) completed by ANSALDO. 3 different W grades have been used.

Small-scale mock-ups (of 5 different monoblock dimensions) and 1 pre-qualification prototype by HIPing completed by PLANSEE.

2 full-scale IVT prototypes by HRPing and HIPing in progress at ANSALDO and PLANSEE respectively.

EU procurement of In-Vessel Components for ITER, Patrick Lorenzetto, IBF 2013
### Divertor Inner Vertical Target
**Near term major calls for tender**

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### CONCLUSION (1/2)

**Blanket First Wall (FW) and Blanket Cooling Manifold (BCM)**

- 1 call for tender for the procurement of CuCrZr alloy plates, planned Q1-2013 (OPE-489).
- 1 call for tender for the manufacture of full-scale FW prototypes, planned Q2-2013 (OPE-443); Interested SMEs to approach pre-qualified companies.
- 1 call for expression of interest for a grant on the development of CuCrZr alloy for the blanket FW HIP fabrication route, planned Q3-2013.
- 3 calls for tender for the procurement of BCM, planned Q2-2014; Pipe bundles, supports & filler shields, coaxial hyd. connectors.
Divertor Cassette Body and Cassette Assemblies

- 1 call for tender for the procurement of divertor cassette bodies, on-going (OMF-444).
- 1 call for tender for the installation of plasma facing components onto the cassette bodies, planned Q2-2014.
- 1 call for tender for the Inner Vertical Target series production, planned Q4-2014; Interested SMEs to approach pre-qualified companies.

For further information please contact us at industryportal-info@f4e.europa.eu
mentioning “In Vessel Components” in subject of your email

Follow us on:

- www.f4e.europa.eu
- www.twitter.com/fusionforenergy
- www.youtube.com/fusionforenergy
Typical sliding supports

Coaxial Connectors

Filler Shields Design 1: fastened onto VV

Filler Shields Design 2: fastened (brazed?) onto pipes

IVT fabrication technologies developed in EU

W to heat sink joints

Tungsten

Cu casting

Pure copper interlayer

HIP’ing

Hot Radial Pressing

CuCrZr

Two joining techniques have been developed in EU to bond the soft Cu to the CuCrZr heat sink tube:

- Hot Isostatic Pressing (HIPing)
- Hot Radial Pressing (HRPing)

**HIPing** can be done at 2 temperatures:

- 900°C, then quenching and age hardening (480 °C for 2 h);
- 550 °C on solution annealed CuCrZr material.

**HRPing** is done at 580 °C for 2 h.
**Objectives**

Address key manufacturing issues,
Perform hydraulic tests,
Establish a procedure for draining and drying the divertor components.
Perform assembly and integration tests on a full-scale prototype with realistic tolerances, dimensions, weight and accessibility.

**Divertor Cassette Body R&D**

**Full scale dummy prototype manufacturing and testing**

**Simulation of Remote Integration of Divertor system**

**EU procurement of In-Vessel Components for ITER, Patrick Lorenzetto, IBF 2013**